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Title of Invention : Sheath Core Composite Fiber

Patent Application No. 97305 - 1990
Date of Application : April 11, 1990

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Specification

1. Title of Invention

Sheath core composite fiber

2. Claims of the Patent

(1) Sheath core composite fiber characterized by that it is the sheath core composite fiber in which the ratio of core component is 30 ~ 90 weight % and the ratio of sheath component is 70 ~ 10 weight %, that the said sheath component is polyamide, that the said core component substantially consists of the 2-component polymer blend of the polyester in which polyethylene terephthalate unit is the main component and the polyethylene -2,6- naphthalate in which ethylene naphthalene -2,6- dicarboxylate is the main component and that the blend ratio of polyester in the said core component is 90 ~ 30 weight %.

(2) Sheath core composite fiber characterized by that, in the sheath core composite fiber described in Claim 1, limiting viscosity [η] of the polyester which is one component of the said core component is over 0.6 and limiting viscosity [η] of the polyethylene -2,6- naphthalate which is the other component of the core component is over 0.6 and the sulfuric acid relative viscosity η_r of the sheath component polyamide is over 2.8.

(3) Sheath core composite fiber characterized by that, in the sheath core composite fiber described in Claims 1 and 2,

strength of the said composite fiber is over 6.0 g/d, elongation is below 20 %, initial tensile resistance is over 60 g/d and dry heat shrinkage is below 7 %.

3. Detailed Description of the Invention

[Field of Applicaiton in Industry]

This invention is related to high strength high modulus fiber which is suitable for application as industrial material, particularly as the rubber reinforcing material. More specifically, the invention is to provide the sheath core composite fiber which has excellent mechanical properties such as high strength, high modulus, and improved dimensional stability and is suitable for use in rubber reinforcement with improved adhesion with rubber, heat resistance in rubber, and improved properties in the interface separation of the core component and sheat component which is the cause of poor durability of the sheath core composite fiber.

[Existing Technology]

The fiber of polyethylene -2,6- naphthalate (hereinafter, this is called 2,6-PEN), representing the naphthalate polyester fiber, in which ethylene naphthalene -2,6- dicarboxylate is the main component has high strength, high modulus, and high heat resistance in rubber and the development of application of this as various industrial materials, particularly as the rubber reinforcing mateiral such as the tire cords, power transmission belts, conveyer belts is being advanced.

From the past, numerous proposals have been made in attempting to improve the adhesion to rubber which is a shortcoming of the fibers such as polyethylene terephthalate, polyethylene naphthalate ; as one of them, the composite fiber made by covering the surface layer of polyester with polyamide and having proper physical property was described in Kokai JP No. 97211 - 1989. The said Kokai JP No. 97211 - 1989 describes the composite fiber in which polyester is the core and nylon 66 is the sheath and specifies the degree of polymerization of the polymer of each component and the ratio of the core section polymer.

[The Problem Which the Invention Intends to Solve]

The composite fiber of sheath core type described in the said Kokai JP No. 97211 - 1989 has considerably inmproved adhesion property and durability ; however, in some application such as the tire which is used under severe conditions like the tire of passenger car running at high speeds, the performance is not sufficient and more improved dimensional stability, heat resistance and riding comfort are required.

In the said Kokai JP No. 97211 - 1989, the adhesion to rubber was improved by the polyamide component of the sheath and the modulus and dimentional stability were maintained by the polyester component of the core. By the said method, the adhesion property is definitely improved to the adequate level but, as to the dimensional stability and heat resistance, they are not different from that of the common polyester fibers and there was no improvement.

Also, the polymer such as polyester and 2,6-PEN have poor miscibility with the polyamide polymer such as nylon 6 and nylon 66 and, consequently, the fiber having the sheath core composite structure made by the common yarn making method easily undergoes the separation and fracture at the interface of the two polymers and does not have sufficient durability for practical use. In particular, the sheath core interface is destroyed by the fatigue of repeated elongation and compression which occur in the drawing process, tire vulcanization process and in tire running and so there is the problem that the performance which is expected of the sheath core composite fiber as usual can not be obtained.

The said 2,6-PEN fiber has inferior adhesion to rubber ; in particular, when exposed repeatedly for long time to the high temperature atmosphere, the adhesion to rubber drops severely. Particularly when used as the tire cord, the heat generated at the time of car running accumulates in the tire and temperature goes high and so the adhesion to rubber is lost and separation occurs in some cases ; also, by the repeated compression and elongation occurring in the tire, the tire cord is fatigued and broken and, as the result, there is the problem of tire bursting.

Objective of this invention is to vercome the said problems in the existing technology and provide the sheath core composite fiber which, in comparison to the existing composite fiber, has much improved dimensional stability, high modulus, in-rubber heat resistance and fatigue resistance and has sufficient durability against the separation of polymer at the sheath core composite interface and so is suitable for use in rubber reinforcement.

[The Means for Solving the Problem and the Action]

The constitution of this invention lies in

(1) The sheath core composite fiber characterized by that it is the sheath core compositte fiber in which the ratio of core component is 30 ~ 90 weight % and the ratio of sheath component is 70 ~ 10 weight %, that the said sheath compo-

nent is polyamide, that the said core component substantially consists of the 2-component polymer blend of the polyester in which polyethylene terephthalate unit is the main component and the polyethylene -2,6- naphthalate in which ethylene naphthalene -2,6- dicarboxylate is the main component and that the blend ratio of polyester in the said core component is 90 ~ 30 weight %.

(2) Sheath core composite fiber characterized by that, in the sheath core composite fiber described in Claim 1, the limiting viscosity [η] of the polyester which is is one component of the said core component is over 0.6 and the limiting viscosity [η] of the polyethylene -2,6- naphthalate which is the other component of the core component is over 0.6 and the sulfuric acid relative viscosity η_r of the sheath component polyamide is over 2.8.

(3) Sheath core composite fiber characterized by that, in the sheath core composite fiber described in Claims 1 and 2, strength of the said composite fiber is over 6.0 g/d, elongation is below 20 %, initial tensile resistance is over 60 g/d and dry heat shrinkage is below 7 %.

In the said sheath core composite fiber which is due to this invention, the core component is the blend of polyester and 2,6-PEN. If the blend ratio of polyester is over 90 wt %, the effect of improvement of modulus and dimensional stability is observable but significant difference is not obtained. If the blend ratio of polyester is less than 30 wt %, fatigue resistance drops and this is not good as the industrial fiber for rubber reinforcement.

In the sheath core composite fiber which is due to this invention, the ratio of core component consisting of the blend of polyester and 2,6-PEN is 30 ~ 90 wt %. If the core component consisting of the blend of polyester and 2,6 - PEN is less than 30 wt %, the dimensional stability, modulus and heat resistance which the polyester and 2,6-PEN have can not be utilized effectively. Also, if the core component consisting of the blend of polyester and 2,6-pen is over 90 wt %, the flexiblity of composite fiber is lost and fatigue resistance drops.

The sheath core fiber which is due to this invention is a fiber which is used mainly in the field of industrial material and it is required to have the strength as one of the numerous performance requirement as an industrial fiber. When the other performance requirements are met, a high strength is required.

In the sheath core composite fiber which is due to this invention, by making the limiting viscosity [η] of the polyester and 2,6-PEN being used as the core component to over 0.6 and by making sulfuric acid relatively viscosity η_r of the polyamide which is the sheath component to over 2.8, the sheath core composite fiber can be made to have high strength and high heat resistance and to be suitable in the industrial applications, particularly as the rubber-reinforcing fibers.

As to the properties of the sheath core cmoposite fiber obtained by using the said blend ratio of polyester and 2,6-PEN polymer and the ratio of polyamide, the sheath core composite fiber which is due to this invention has a high strength of over 6.0 g/d, initial tensile resistance of over 60 g/d, elongation of less than 20 % and dry heat shrinkage of less than 7.0 %. Preferred properties of the composite fiber satisfy the strength of over 7.0 g/d, the initial tensile resistance of over 70 g/d, the elongation of 8 ~ 16 % and the dry heat shrinkage of less than 6.0 %. With this, it becomes excellent industrial fiber, particularly rubber reinforcing fiber having much improved dimensional stability, high modulus, heat resistance, fatigue resistance and durability against the polymer separation at the interface of sheath core composite.

The polyester which is one of the components of the core componenet of the sheath core composite fiber due to this invention is the polyester which has limiting a viscosity [η] of over 0.6, preferably over 0.7, and practically consists of polyethylene terephthalate unit. It also may contain a copolymer component within the extent of not allowing substantial reduction of physical and chemical properties of the polyethylene terephthalate polymer, for example less than 10 %. As for the copolymer component, examples are the dicarboxylic acid such as isophthalic acid, naphthalene dicarboxylic acid, the diol component such as propylene glycol, butylene glycol and the ethylene oxide.

As to the 2,6-PEN which is the other component of the core component of sheath core composite fiber due to this invention, the main component is substantially the ethylene naphthalene -2,6 - dicarboxylate of limiting viscoisty [η] of over 0.6, preferably over 0.7 ; when necessary, it may contain a copolymer component within the extent of not allowing a substantial reduction of physical and chemical properties of 2,6-PEN, for example less than 10 %. As for the copolymer component, the dicarboxylic acid such as isophthalic acid, diphenyl dicarboxylic acid, the diol component such as ethylene oxide, propylene glycol, butylene glycol or

other component are use.

On the other hand, as for the polyamide which is used as the sheath component of sheath core composite fiber which is due to this invention, examples are polycapramide, polyhexamethylele adipamide, polytetramethylene adipamide, polyhexamethylene sebacamide, polyhexamethylene dodecamide, polyhexamethylene terephthalamide, polyhexamethylene isophthalamide ; among them, the polyhexamethylene adipamide - based polymer is used preferably.

To the above mentioned polyamide, one can copolymerize or blend the ε -capramide, tetramethylene adipamide, hexamethylene secacamide, hexamethylene dodecamide, polyhexamethylene terepthalamide, polyhexamethylene isophthalamide within the extent of not allowing substantial reduction of the properties, particularly the strength, for example less than 10 %.

Also, to the above said polyamide, one can add, within the extent of not allowing the reduction of properties such as the strength of the fiber of this invention, other additives which impart other properties, for example the thermal oxidation degradation prevention agent, delustering agent, pigment, light stabilizer, thermal stabilizer, antioxidant, antistatic agent, dyability improving agent, adheison improving agent, etc. Particularly as the thermal oxidation degradation prevention agent, one can add the copper salt and other inorganic and organic compound. When used in industrial applications, it is preferred to contain 30 ~ 500 ppm, as copper, of the copper salt such as copper iodide, copper acetate, copper chloride, copper stearate, 0.01 ~ 0.5 wt % of alkali metal halide such as potassium iodide, sodium iodide, potassium bromide and/or 0.01 ~ 0.1 wt % of organic, inorganic phosphorus compound.

The sheath core composite fiber which is due to this invention can be made by the novel method described below in detail.

As for the polyester which is one component of the above mentioned core component, the polyester which consists substantially of the polyethylene terephthalate of limiting viscosity [η] of over 0.6, normally over 0.7, is used.

As for the 2,6-PEN which is the other component of the core component, the 2,6-PEN having a limiting viscosity [η] of over 0.6, normally over 0.7, in which the main component is substantially ethylene naphthalene-2,6-dicarboxylate is used.

For the polyamide of the sheath component, the polymer of high degree of polymerization having a sulfuric acid relative viscosity of over 2.8, normally over 3.0, is used.

The polyester polymer and 2,6-PEN of the core component are either blended by using a mixing apparatus after melting each of them separately in an extruder or the two polymers are blended and then it is melted. Melting temperature is 290 ~ 330 deg C.

On the other hand, the polyamide polymer of the sheath component is melted in a separate extruder at 280 ~ 310 deg C.

The above mentioned core component polymer obtained by blending the molten polyester and 2,6 PEN polymer and the sheath component polymer consisting of the polyamide polymer are led to the composite spinning apparatus which is heated at 290 ~ 310 deg C and these are spun into the sheath core composite fiber through the die for composite spinning.

The spinning speed is a high speed at over 1000 m/min. Directly underneath the said composite spinning die, there is installed the heat preserving cylinder, heated cylinder for the heated atmosphere of over 200 deg C, preferably over 260 deg C, for a distance of over 10 cm and less than 1 m. The spun sheath core composite fiber is passed through the above mentioned heated atmosphere and then it is quenched and solidified by cold air ; then, it is imparted with the oiling agent and then is taken up by the take up roll which controls the spinning speed. The sheath core composite fiber which was taken up is the undrawn yarn.

Control of the heated atmosphere directly underneath the said die is important for maintaining spinnability at the time of high speed spinning in this invention. The undrawn yarn which was taken up is either drawn continuously without winding up first or it is first wound up and then is drawn in a separate process.

Use of high speed spinning gives the effect of improving the dimensional stability of the composite fiber at high tempeature, the effect of improving durability and the effect of improving the durability against the separation at the sheath core interface.

Next, the said undrawn yarn is heat-stretched at the temperature of over 80 deg C, preferably over 200 deg C, to make the drawn yarn. Drawing is done in more than 2 stages, normally in more than 3 stages and the draw ratio is in the

range of 1.1 ~ 7.0.

The drawn yarn thus obtained has the characteristics of the above described sheath core composite fiber which is due to this invention.

Next, explanation is given on the basis of examples of application. The definitions and methods of measurements of the fiber properties and cord properties described in the text of specification of this invention and in the examples of application are as follows.

Properties of the polyester core component

Limiting viscosity [η] :

The sample was dissolved in ortho chloro phenol solution and measurement was made at 25 deg C by using the Oswald viscometer.

Properties of the 2,6-PEN core component

Limiting viscosity [η] :

The sample was dissolved in the mixed solvent of phenol and ortho dichloro benzene (mixing ratio 6:4) and measurement was made at 25 deg C by using Oswald viscometer.

Properties of the plyamide sheath component

Sulfuric acid relative viscosity η_r :

0.25 g of the sample was dissolved in 25 cc of 98 % sulfuric acid and measurement was made at 25 deg C by using the Oswald viscometer.

Properties of the composite fiber

(a) Strength, elongation, initial modulus

As for the strength, elongation, initial modulus, the definition and methods of measurements of JIS L 1017 were followed. Specific conditions at the tensile test for obtaining the SS curve were as follows.

Sample was taken in skein form and this was kept for over 24 hours in a room where temperature and humidity were controlled to 20 deg C and 65 % RH; then, using the "Tensilon UTL -4L" Model tensile testing machine (made by Orientech (K.K.)), measurement was made with a sample length 25 cm and tensile speed of 30 cm/min.

(b) Dry heat shrinkage :

Sample was taken in skein form and this was kept for 24 hours in a room where the temperature and humidity were controlled to 20 deg C, 65 % RH; after this, a load correspond-

ing to 0.1 g/d of sample was applied and the length L of the sample was measured. This sample was then treated for 30 minutes in an oven at 150 deg C with no tension applied. The sample after the treatment was dried with air and this was kept for 24 hours in the above mentioned room with the controlled temperature and humidity. After this, the above said load was applied again and the length Lo was measured and the value was calculated by the following equation.

Dry heat shrinkage = (L - Lo)/L x 100

Properties of the composite fiber cord

(a) Strength, elongation, intermediate elongation

Measurements were made in the same manner as in the case of previously mentioned fiber. The intermediate elongation refers to the elongation when the force determined by the following equation is exhibited.

(4.5 x D x n) / (1000 x 2) Kg

where D : Drawn yarn denier
n : Number of yarns twisted together

For example, for the cord 1500/2 obtained by having 2 pieces of drawn yarns of 1500 denier / yarn twisted together, the elongation at 6.75 Kg is the intermediate elongation.

(b) Dry heat shrinkage

The treamtent temperature was 177 deg C. Other than this, the measurement was made in the same manner as in the above said composite fiber.

(c) GY fatigue life :

The method of JIS L1017-1.3.2.1A was followed. The bending angle was 90 degrees.

(d) GD fatigue life

The method of JIS L1017-1.3.2.2 was followed. Elongation was 6.3 % and compression was 12.6 %.

(e) Adhesion :

JIS 1017-3.3.1A was followed.

(f) Heat resistant adhesion :

Heat treatment at the time of vulcanization was 170 deg C/60 minutes. Other than this, the same method as in (e) was used for the evaluation.

(g) Heat resistance in rubber

The dip cord arranged on a rubber sheet was sandwiched by using another rubber sheet which was prepared separately and this was heat treated for 3 hours under a pressure of 50 kg/cm^2 in a press which was heated to 170 deg C. Strength of the cord was measured before and after the treatment and the strength retention was calculated and this was used as the measure of heat resistance.

[Examples of Application]

Examples of Application 1 ~ 3, Comparative Examples 1 ~ 7

The polymer obtained by blending the polyester polymer of limiting viscosity [η] 0.8 and 2,6-PEN polymer of limiting viscosity [η] 0.8 and the hexamethylene adipate polymer of sulfuric acid relative viscosity η_r 3.3 containing copper iodide 0.02 wt % and potassium iodide 0.1 wt % were melted separately by 40 ϕ extruder type spinning machines and these were led to the composite spinning pack ; from the sheath core composite spinning die, spinning of the composite fiber was done with the blend polymer of the polyester and 2,6-PEN as the core and with the hexamethylene adipamide polymer as the sheath. The blend ratio of polyester and 2,6-PEN of the core component and the composite ratio of the core component and sheath component are shown in Table 1. For the die, one with hole diameter 0.4 mm ϕ and number of holes 120 was used. As to the polymer temperature, the blend polymer of polyester and 2,6-PEN was melted at 305 deg C and the hexamethylene adipamide was melted at 290 deg C and the spinning pack temperature was kept at 295 deg C in spinning. Directly under the die, a heated cylinder of 30 cm was installed and the atmopheric temperature in the cylinder was kept at 300 deg C by heating. The atmospheric tempeature in the cylinder is the temperature of the atmosphere measured at the position which is 10 cm below the die face and 1 cm apart from the filament at the outermost circumferential position. Under the heated cylinder, a chimney of annular shape with a length of 40 cm was attached and, from around the yarn, cold air at 20 deg C was blown at 40 m/min perpendicularly against the yarn for cooling. Then, the oiling agent was imparted and the yarn speed was controlled by the take up roll rotating at the speed shown in Table 1 and then, without winding up first, this was drawn continuously. Drawing was conducted in 3 stages by using 5 pairs of Nelson type rolls ; after this, 3 % relaxation was given for relaxation heat treatment and then it was wound up. As for the drawing conditions, the take up roll temperature was 60 deg C, the first draw roll temperature was 120 deg C, the second draw roll temperature was 190 deg C, the third draw roll tempeature was 220 deg C, and the tension control roll after drawing was not heated.

The first stage draw ratio was 70 % of the total draw ratio and the remainder was divided into 2 stages for drawing: The spinning was conducted with the variation of extrusion rate matched to the spinning speed and draw ratio such that the denier of drawn yarn would be about 500 denier. 3 pieces of the drawn yarn were put together to make 1500 denier.

The yarn-making condition, properties of the drawn yarn and the fiber structure parameters are shown in Table 1 together with those of the nylon 66 fiber (1260-204-1781) and polyethylene terephthalate (PET) fiber (1500-288-702C) for tire cords which are sold in the market.

Using the drawn yarns which were obtained in the above described examples of application, 1500/2 greige cord was made by applying 40T/10 cm twisting for the upper twisting and lower twisting in reverse directions, respectively. For N66, however, number of tiwsting was 39T/10 cm to make 1260/2 greige cord. These greige cords were made into dip cords by imparting adhesive agent and conducting heat treatment by using the dipping machine of Ritzler Co.

The dip solution contained 20 % of the adhesive component consisting of resorcine, formalin, latex and the imparting was controlled so that the adhesive component will stick by 4 %. Heat treatment was conducted at 220 deg C for 80 seconds by applying a stretch such that the intermediate elongation of the dip cord would be about 15 %.

Nylon 66 was treated under the same heat treatment condition by applying a stretch such that the intermediate elongation would be about 9 %. For the PET fibers, the 2 bath adhesion treatmnet was conducted by the common method and the heat treatment was conducted at 240 deg C for 120 seconds by applying a stretch so that the intermediate elongation would be about 5 % .

For the dip cords which were obtained in this manner, the heat resistance in rubber, adhesion property and fatigue resistance were evaluated and the results were shown in Table 2.

The dip cord of sheath core composite fiber of this invention has fatigue resistance which is better than the existing polyester dip cord and it shows to be a high strength dip cord having much improved modulus, dimensional stability, in-rubber heat resistance and heat resistant adhesion property.

Table 1, Table 2 (See the table of next page with the following translations of headings).

C1. Comparative Example 1; E1. Example of Application 1

1. Core component polymer blend ratio ; 2. Polyester ratio (wt %) ; 3. 2,6-PEN*1 ratio (wt %) ; 4. Core component, sheath component polymer composite ratio ; 5. Core component ratio *2 (wt %) ; 6. Sheath component ratio *3 (wt %) ; 7. Spinning speed (m/min) ; 8. Draw ratio (times) ; 9. Properties of the composite fiber ; 10. Denier (d) ; 11. Strength (g/d) ; 12. Elongation (%) ; 13. Initial modulus (g/d) ; 14. Dry heat shrinkage (%) ; 15. Intermediate elongation (%) ; 16. Adhesion property (Kg) ; 17. Heat resistant adhesion (Kg) ; 18. In-rubber heat resistance (%) ; 19. GY fatigue life (min.) ; 20. GD fatigue life (%)

*1. 2,6-PEN : polyethylene -2,6- naphthalate ;
*2. Polyester and 2,6-PEN blend polymer component
*3. Polylamide polymer component

[Effectiveness of the Invention]

The sheath core composite fiber of this invention, compared to the existing composite fibers, has much improved modulus, dimensional stability and in-rubber heat resistance and also has much improved adhesion, particularly the heat resistant adhesion after being subjected to a high temperature history and fatigue resistance. For this reason, for example in the case of using as tire cord, the durability against the repeated fatigue in tire running and against heat generation in running is very good. In other words, it is useful as the tire cord for use in the tires of relatively large sized passenger cars, light truck and truck and bus. In particular, it is most suitable for the carcass cord of large sized radial tires.

Also, the sheath core composite fiber of this invention has the above described excellent properties and so it can be used as the rubber reinforcing material other than tire cords as well as for the general industrial material applications.

Patent Applicant : Toray K. K.

表1

C1 E1 C2 C3 E2 C4 C5 E3 C6 C7

		比較例－1	実施例－1	比較例－2	比較例－3	実施例－2	比較例－4	比較例－5	実施例－3	比較例－6	比較例－7
1	芯成分ポリマブレンド割合										
2	ﾅｲﾛﾝ6割合 (重量%)	95	60	20	60	60	60	60	60	100	–
3	2,6-PEN*1 割合(重量%)	5	40	80	40	40	40	40	40	–	–
4	芯成分、鞘成分ポリマ複合比率										
5	芯成分比率*2 (重量%)	60	60	60	20	70	95	70	70	–	–
6	鞘成分比率*3 (重量%)	40	40	40	80	30	5	30	30	–	100
7	紡糸速度 (m/min)	1500	1500	1500	1500	1500	1500	500	2000	–	–
8	延伸倍率 (倍)	3.32	3.29	3.27	3.26	3.29	3.30	5.82	2.75	–	–
9	複合繊維の物性										
10	繊度 (d)	1512	1516	1511	1516	1500	1517	1500	1503	1512	1258
11	強度 (g/d)	7.30	7.40	7.34	6.98	7.56	7.71	8.18	6.90	9.33	9.60
12	伸度 (%)	15.0	15.7	15.9	15.5	15.1	15.7	15.1	15.5	12.3	19.8
13	初期モジュラス (g/d)	90.2	126.3	137.3	62.0	136.3	123.2	58.1	126.4	102.0	42.3
14	乾熱収縮率 (%)	7.20	5.3	5.0	6.6	5.0	4.4	8.3	4.0	6.1	4.9

*1 2，6－PEN：ポリエチレン－2，6－ナフタレート
*2 ポリエステルと2，6－PENのブレンドポリマ成分
*3 ポリアミドポリマ成分

表2

C1 E1 C2 C3 E2 C4 C5 E3 C6 C7

		比較例－1	実施例－1	比較例－2	比較例－3	実施例－2	比較例－4	比較例－5	実施例－3	比較例－6	比較例－7
10	繊度 (d)	3501	3502	3501	3511	3497	3518	3496	3500	3512	2744
11	強度 (g/d)	6.01	6.14	6.10	5.50	6.38	6.44	7.02	5.91	6.10	7.92
12	伸度 (%)	16.5	16.5	16.6	16.0	16.2	16.7	15.5	16.3	14.9	22.8
15	中間伸度 (%)	4.9	5.1	5.0	4.9	4.8	5.3	4.9	4.8	5.1	9.6
14	乾熱収縮率 (%)	5.2	4.5	4.3	6.2	4.3	4.4	7.4	4.1	5.1	6.3
16	接着性 (Kg)	21.6	22.0	21.6	21.0	21.1	18.3	21.3	21.9	16.8	20.9
17	耐熱接着性 (Kg)	19.9	19.4	19.1	20.0	20.3	16.9	20.4	20.5	14.5	20.3
18	ゴム中耐熱性 (%)	71.2	73.5	79.1	74.4	71.5	77.2	71.1	70.1	50.6	96.8
19	GY疲労寿命 (分)	372	353	218	400	348	176	194	360	128	459
20	GD疲労寿命 (%)	73.9	69.8	63.2	72.4	70.3	54.2	54.9	78.3	51.7	78.9